

Running Head: THE IMPACT OF RISK PERCEPTION ON SMOKE ALARM USE

Leading Community Risk Reduction

The Impact of Risk Perception on Smoke Alarm Use in the City of San Bernardino,
California.

James M. Fratus

San Bernardino City Fire Department, San Bernardino California.

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Abstract

The City of San Bernardino CA. was experiencing fatal fires in residential occupancies at a higher rate than the State and National averages. Working smoke alarms were lacking in all of the fatal fires. The purpose of this research was to determine if a relationship existed between a community member's perception of risk, and their choice to maintain a working smoke alarm in their residence. Emphasis was placed on residences with citizens under age 14 and over age 65. Descriptive research methods were used to determine the existence and impact of this relationship. The research found that people whose perception of personal risk was accurate were more likely to have working smoke alarms than those with less accurate risk perception.

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The Impact of Risk Perception on Smoke Alarm Use in the City of San Bernardino CA.

Introduction

The problem of civilian fire fatalities in the United States is one that continues to plague the leaders of the American fire service. Even as one of the most technologically and socially advanced countries in the world, the United States continues to experience death rates due to fire that are among the highest of the industrialized nations (United States Fire, 2004). This grim statistic is even more evident in the City of San Bernardino, California.

With a population of nearly 184,400, the City of San Bernardino has experienced an annual civilian fire fatality rate equivalent to over 22 deaths per million on average from 1998 through May of 2005 (San Bernardino City, 2005). This is approximately 39% above the national average, and over 4 times greater than the State of California annual average for the period between 1992 and 2001 (United States Fire, 2004). In 2002, the City of San Bernardino experienced its highest fire death rate of the eight year period with the equivalent of 50 deaths per million.

This is a troubling statistic for the local government officials and the members of the San Bernardino City Fire Department (SBFD) who struggle to identify ways to protect their citizens from the hazards of fire. Although no single factor has been identified in the cause of these fires, one significant contributing factor to the fatalities has been identified as the absence of properly functioning smoke alarms in all of the structures where the fatalities occurred.

This absence of working smoke alarms is a disturbing trend, mainly because SBFD has been very active in publicly demonstrating the needs and benefits of having working smoke alarms in the home. The department also provides smoke alarms to any resident of the city at no charge. The city's fire mortality trend has not improved in spite of these efforts.

Through further observations, the SBFD has determined that although some of the homes where fatal fires had occurred did have a smoke alarm present, it did not function properly. In each of these cases, however, the failure was a result of a human act or omission (presumably by the occupant) prior to the fire event that caused the failure of smoke alarm to perform properly. These acts and omissions range from disconnecting the power source to failing to maintain the smoke alarm's battery. In no case was the smoke alarm found to be inherently defective.

Based on these findings, it is reasonable to conclude that if the SBFD is going to successfully decrease residential fire fatalities through an increased presence of working smoke alarms, there will need to be a focus on the human behavioral elements associated with choosing to install and maintain them. Certainly, there is likely to be several human factors associated with this trend. However, one specific human behavior characteristic that may significantly influence a person's choice to obtain and maintain a smoke alarm in their residence is their perception of the risk level associated with a fire in their home.

The purpose of this research is to determine if there is a relationship between a community member's understanding of the risks associated with a fire in their home, their ability to put this risk in perspective with other risks, and the presence or absence of a working smoke alarm in their residence. Understanding the strength of this relationship

will provide the SBFD with the insight needed to improve and further develop their public education strategies for decreasing life loss due to residential structure fires by increasing smoke alarm use in the community.

Descriptive methods will be used in conducting this research. Using data collected through a questionnaire given to community members of San Bernardino City, the research will first answer the question of how many respondents have a working smoke alarm in their home. From there, the research will assess how well these same respondents can estimate their actual personal risk from a group of specific hazards, including a fire in their home. These two questions will form the basis of a third question which seeks to determine if there is a connection between the accuracy of community member's understanding of their personal risks, and their choice to maintain a working smoke alarm in their residence.

The final question that the research will seek to answer will be what, if any, impact does a connection between risk perception and smoke alarm use and maintenance have on occupants of each residence that are under the age of 14 or over the age of 65. This is significant because these age groups statistically face a dramatically increased risk of dying in a residential fire (United States Fire, 2005a).

Based on the findings of this research, recommendations will be made for decreasing life loss due to fire in the City of San Bernardino by increasing smoke alarm use and maintenance.

Background and Significance

On the dirt front yard of the house located in the North-West section on the City of San Bernardino CA., the words *Tina, we will miss you* were scrawled along with a

crude image of a butterfly. Two days prior, the six occupants of the home at that location were killed in an early morning fire that was referred to by many as the city's worst home fire incident in over 30 years (Goad, 2003). Three of the occupants who perished were under the age of 14.

Unfortunately, tragic losses of life in residential structure fires such as this one are not an anomaly in the City of San Bernardino. Although this fire represented significant life loss in a single event, it was only one of 18 fatal residential structure fires that occurred over an eight-year period from October of 1998 to May of 2005. Collectively, these fires caused 33 civilian fatalities. While each of these fires occurred in different areas of the city, and under a variety of circumstances, the one common element in each was that there were either no smoke alarms in the residence, or when one was present, it was not functioning properly.

This aspect of the fire mortality problem in the City of San Bernardino is significant, as there is considerable evidence that indicates that the presence of working smoke alarms in residential structures greatly reduces the risk of death and property loss due to fire (United States Fire, 2001). Recognizing this fact, the fire commissioners for the SBFD initiated a smoke alarm giveaway program in April of 2002. This program provided smoke alarms and/or batteries, free of charge, to any resident of the city who requested such.

Although over 2,200 smoke alarms and 1,200 additional batteries were given away as of April of 2005, there have still been 21 civilian fatalities in residential structure fires since the inception of the program. Again, in all cases, either a smoke alarm was not present, or ones that were present were not functioning properly.

Further investigations of the smoke alarms that were present at fatal fire incidents, but not functioning, found that the devices failed because dead batteries were not replaced, batteries were removed, or external power supplies were disconnected. In one case, a working smoke alarm was placed in a dresser drawer. Although it did activate, it was not audible to the occupants. There was no evidence in any of the incidents indicating that a smoke alarm failed to function because of an internal failure of the smoke alarm itself (San Bernardino City, 2005).

Although the smoke alarm give away program continues, along with an aggressive fire inspection and enforcement program, the statistics suggest that the problem may not be with the availability of smoke alarms, but with the lack of a conscious effort by occupants to obtain one, and/or ensure that it remains functional.

While this is a disturbing trend, it does not appear to be unique to the City of San Bernardino. Studies from the United States Fire Administration show that although an estimated 90% of residential structures in the United States have a smoke alarm installed, they were present in only 58% of fatal residential structure fires, and operational in only 37% of those fires (2005). These facts suggest that although the efforts of the fire service to increase the availability of smoke alarms is showing progress, there are still behavioral issues among American citizens that are inhibitors to a real solution to the fire mortality problem.

Unlike many of the risks associated with other natural and man-made hazards, the risks from a fire in the home can be managed to a great extent by the occupants of a household. Specifically, ensuring that smoke alarms are present in the home, properly installed, and maintained is a risk reduction practice in which the occupants have

complete control over. Simply put, community members need only to choose to practice this safety behavior in order to decrease the likelihood of dying in a residential structure fire. Because this does not appear to be happening on a wide enough basis in the City of San Bernardino, it raises the question of whether community members truly understand the level of risk that a fire in the home presents to them.

If in fact an inaccurate perception of risk is a factor in San Bernardino City's smoke alarm problem, then much could be gained by researching and understanding its impact. Identifying such a relationship would be vital in developing and implementing public education strategies for decreasing life loss due to residential structure fires by increasing smoke alarm use in the community. Evaluating community members' perceptions of risk and the impact that those perceptions have on life safety issues supports key concepts of the Leading Community Risk Reduction course in the National Fire Academy's Executive Fire Officer program (Federal Emergency, 2004).

The research will also look specifically at the impact that this relationship may have on community members under the age of 14 or over the age of 65, as these age groups statistically face a dramatically increased risk of dying in a residential fire. This approach to the research supports one of the five-year operational objectives of the United States Fire Administration, which calls for a 25% decrease in life loss from fire in these age groups (Federal Emergency, 2002)

Literature Review

The literature review for this applied research project focused on the effectiveness of smoke alarms in reducing life loss in residential structure fires, the human factors associated with personal risk assessment and acceptance, and the statistical risk of fire

and other specific non-fire hazards to the community. In the area of statistical community risks, special emphasis was placed on community members over the age of 65 and under that age of 14.

The Effectiveness and Use of Smoke Alarms

The availability and use of smoke alarms in residential occupancies has increased substantially in the United States since their introduction in the early 1970s (United States Fire, 2001). By the year 2000, the National Center for Injury Prevention and Control estimated that 94% of all U.S. households had a smoke alarm installed (as cited in United States Fire, 2001).

The effectiveness of residential smoke alarms in reducing life loss due to structural fires is well documented. Statistics from the National Fire Protection Association (NFPA) indicate that homes with working smoke alarms have a death rate from fire that is 40-50% lower than those homes that do not have a working smoke alarm (Smoke Alarms, 2005). In a study of smoke alarm usage in the United States, Ahrens (2004) estimated that if every home had a working smoke alarm installed, residential fire deaths would decrease by 36%, resulting in an estimated 1,120 lives saved per year.

Additional research shows that the effectiveness of smoke alarms is strongly influenced by an occupant's choice to correctly install and maintain the devices. A United States Fire Administration study of smoke alarm performance in residential structure fires (2001) shows that smoke alarms were not present or did operate in 75% of residences where a fire fatality occurred. The research further found that statistically, when the number of fatalities per fire incident increased, the presence of operational smoke alarms decreased.

In those cases where a smoke alarm was present, but failed to work, the most common reason was a failure at the power source, such as dead or missing batteries, or disconnection from a domestic power supply (Ahrens, 2004). In a similar study, which attempted to determine why smoke alarms fail in residential structure fires, Smith (1995) found that 60% of the alarms studied failed to function because they were disconnected from their power sources. In both studies, the factor that had the greatest control over the operability of the smoke alarms was the human behavior associated with making the choice to maintain the smoke alarm, or disable it.

The Impact of the Fire Problem on Young Children and Older Adults

Although the U.S. fire problem stretches across all age groups, the impact of residential structure fire mortality is statistically greater for children under the age of 14 and adults over the age of 65. In the case of older adults, a U.S. Fire Administration (2005c) report on older adult casualties in residential fires states that adults over the age of 65 comprised 27% of all residential fire deaths in 2002. In addition to having one of the highest casualty rates in the country, adults over age 65 also have the highest relative risk of fire death (United States Fire, 2004). As in the case with the general population, the presence of working smoke alarms has shown to increase the probability of surviving a residential structure fire in this age group (United States Fire, 2001).

Ironically, Hall (1999) found that a common misconception of older adults is that they believe they are relatively safe from fire, when in fact they are one of the most at-risk populations of being injured or killed by fire. The impact of this misconception is significant, and will be discussed in detail later in this research.

The statistics regarding the mortality rate of children in residential fires are equally disturbing. A report by the U.S. Fire Administration (2005b) on residential fires and child casualties showed that 2,490 children 14 years or younger died in residential structure fires in 2002. According to the National Center for Injury Prevention and Control, fires and burns were the third leading cause of unintentional injuries to infants and the 12th overall cause of unintentional injuries among children age 14 or younger, accounting for 121,000 injuries in 2002 (as cited in United States Fire, 2005b). As was found with the general population and with adults over the age of 65, the presence or absence of working smoke alarms is a significant factor in the survival rate for under 14 age group as well (United States Fire, 2001).

Recently, there have been concerns raised over the audibility effectiveness of smoke alarms in waking sleeping children. A literature review conducted by the Consumer Product Safety Commission (CPSC) (2004) cited several studies that found evidence of low responsiveness to smoke alarm activation in children under the age of 16 who were sleeping at the time of activation. The report suggests that this low responsiveness is primarily due to deeper sleeping periods in this age group, which would require a louder sound than the standard smoke alarm delivers to stimulate wakefulness.

However, the CPSC report also concludes that even with these observations, there is no evidence that children have a higher fire death rate because of the inability to wake to a smoke alarm. Therefore, even with contentions that children sleep through the sound of a smoke alarm, the devices are still seen as the foundation of fire safety in the home (Children and Smoke, 2002).

The Influence of Risk Perception on Acceptance or Avoidance of risk.

In reference to risk perception, Prof. Peter Sandman of Rutgers University said that “the risks that kill you are not necessarily the risks that anger and frighten you.” (1987 p.21). This observation offers insight into the human behavior that influences people to make choices that may or may not be in their best interest when it comes to personal risk management.

There is evidence of a certain level of predictability in the behavioral patterns of risk acceptance or risk avoidance in humans. In studying individuals’ attitudes toward risk, Webber, Blais, & Betz, (2002) found that although very few of the respondents in their study showed a willingness to engage in risky behaviors, the level of risk that they were willing to engage in was based largely on perceived benefit. Similar conclusions were made by Roepik (2002) in his study of risk perception, where he found that the more people perceive a benefit from a potentially hazardous agent, process, or activity, the less fearful they are of the risk.

In another study of human patterns of risk, Webber et al. (2002) found that most of the respondents who were likely to engage in risky behavior did so because they believed the behaviors were not very risky. This lack of a reference point for establishing the true risk of a specific hazard is a significant factor in assessing why some individuals who would not consider themselves “risk takers”, appear to be willing to accept what is in reality a significant risk.

Kunreuther, Meyer, and Van den Bulte found this risk perception element to be significant through their observation that “people may have difficulty gauging how concerned to feel about a 1 in 100,000 probability of death without some comparison

points. Most people just do not know whether 1 in 100,000 is a large risk or a small risk.” (National Institute, 2004, p. 31).

When clear and logical reference points are not made available, people in general will be strongly influenced by sources that do not necessarily portray an accurate level of risk for a specific hazard. Finucane, Alhakami, Slovic and Johnson (2000) suggest that a primary source influencing an individual’s judgment of risk are the positive and negative feelings attached to their personal mental images connected with the risk. As such, people will assign a level of risk associated with a hazard based on their own experiences, and the feelings that these experiences (positive or negative) created for the individual. Judgments of risk are then guided by reflecting back on these feelings.

This naturalistic decision making model can produce a cognitive bias that is inherently flawed, as it is based largely on the individuals personal knowledge and experience base, and not necessarily on statistically correct evidence (Groner, 1999). This knowledge and experience base may then form a mental model of risk that is inaccurate.

Evidence of this was illustrated in a survey conducted by the National Fire Protection Agency (NFPA), which found that more respondents believed that they were at greater risk from a tornado than they were from a fire in their home. The study’s statistics, however, showed that the opposite was true. For example, the report showed that in 2003, there were only 70 deaths resulting from tornadoes, while the number of fatalities from fire was 3,927, thus illustrating the disparity that often develops between real and perceived risk (Nicholson, 2004).

Groner (1999) illustrates how such faulty mental models develop by using the example of individual’s frequent exposure to controlled fire, such as a fireplace or

campfire. He stated that experiences such as these will typically generate feelings that are positive and non-threatening. After multiple occurrences isolated to these observations and experiences, the individual may develop the belief that the fire behavior of an uncontrolled fire in the home would be similar in size, rate of spread, and controllability to the controlled fire they are familiar with. This would likely generate a response to an uncontrolled fire in the home that may include apathy, underestimation of the potential impact of the fire, and an overestimation of their ability to control it.

This perception versus reality problem has been identified as a significant component of the fire mortality problem in the United States. In examining fire and life safety issues, Hall (1999) found that although most people believe they are safest in their home, in reality, the risk of dying in a fire is greatest in one's home and in one's car. Hall also countered the common misconception that a person has about 10 minutes to escape from a building that is on fire with statistical evidence showing that a person has only 2 to 4 minutes before flashover makes the building untenable for humans.

Recognizing that an individual's perception of risk develops through personal knowledge and experience, Oglethorp and Monroe (1994) concluded that individuals must be provided with enough accurate information about specific risks if they are to make an informed choice to avoid them. Their research suggests that information about a given risk, including controllability, catastrophic potential, dreadedness, and reversibility should all be included in the portrayal of risk, as these elements will synthesize into perceived risk.

The recentness of a specific hazard event also appears to influence not only the perception of risk for that specific hazard, but also an individual's response to it. Chilton,

Covey, Hopkins, Jones-Lee, Loomes and Pidgeon (2002) found evidence of this in two identical studies that were conducted in 1998 and in 2000 in the United Kingdom. The purpose of the studies was to analyze the perceptions of risk in the contexts of rail use, domestic fires, and fires in public places.

The study conducted in 2000 offered a unique opportunity to analyze the effect of recent hazard events on risk perception, although due to unplanned events. Less than a year before the 2000 studies were conducted, there was a major rail accident near London's Paddington Station, which resulted in 31 fatalities. Afterwards, the study showed a significant increase in the survey respondent's priority given to rail safety as compared to the 1998 study. The authors of the study suggest that some of the primary reasons for this shift included the respondents having a higher perceived personal exposure to rail risks, and a heightened feeling of dread concerning rail risks.

Another significant aspect of the Chilton et al. (2002) study was that although the level of concern for rail safety increased in 2000, the level of concern for the remaining contexts in the study, domestic fire and public fires, remained nearly the same, or decreased slightly. This finding further supported the theory that the increase in rail hazard awareness in the 2000 study was strongly influenced by the rail accident at Paddington Station.

The Statistical Risks Associated with Specific Hazards

In order to establish a baseline for determining how well respondents to this research project's questionnaire understand the level of risks associated with the specific hazards used, a review of each hazard's risk potential was performed (see questionnaire in appendix A). Some of the hazards identified in the questionnaire, such as airplane

crashes, car crashes, and a fire in the home could be assessed from a national perspective as they are not necessarily unique to specific regions. Other hazards used, such as hurricanes, tornadoes, wildland fires, and earthquakes require a region specific analysis, since the impacts of these hazards will differ significantly depending on geographic area.

A report published by the National Safety Council (NSC) (National Safety, 2005) compiled historical mortality data from National Center for Health Statistics and U.S. Census Bureau to determine the average American's lifetime odds of dying from a number of different causes. Table 1 summarizes some of the findings of this report by outlining the odds of dying from eight of the hazards used in the questionnaire, with the hazard having the highest likelihood of causing death ranked at number one, and descending from there.

Although the NSC report was based on some of the most reliable sources available, it does have some limitations. The odds given are based on statistical averages over the whole U.S. population. Therefore, they do not necessarily reflect the variables that impact an individual's odds of dying from various external causes resulting from the environmental, geographic, and geologic factors. Because of these variables, additional sources and factors must be considered in order to establish the level of risk specific to the citizens living in the City of San Bernardino. For example, according to the NSC, the lifetime odds of dying in a hurricane are approximately 1 in 59,127.

However, Williams' (2005) study of National Weather Service data found that there are no records of a hurricane ever hitting the coast of California. This is due in large part to the fact that the coast of California lies about 800 miles from water warm enough

to sustain a hurricane (Atlantic, 2004). Therefore, because these weather events are predictably very rare in California, the odds of a person in San Bernardino City actually dying from a hurricane are likely to be lower than any of the other hazards listed.

Table 1
Statistical Odds of Dying as a Result of Specific Selected Hazards for the Average American.

Hazard	Mortality Ranking ^b	Lifetime odds of dying ^a
Car Crash	1	1 in 226
Fire in the home	2	1 in 1,471
Airplane Crash	3	1 in 5,704
Hurricane	4	1 in 59,127
Tornado	5	1 in 60,000
Wildland Fire	6	1 in 70,283
Earthquake	7	1 in 120,161
Flood	8	1 in 413,887
Terrorist attack	9	N/A

^aLifetime odds of dying determined by the National Safety council.

^bMortality ranking is based on the hazards listed for this research only. Other hazards not listed may rank higher or lower than those listed in this table.

Tornadoes are another example of a hazard that was used in the questionnaire that will have varying levels of risk in different geographic regions. According to the NSC report, the odds of dying in a tornado are approximately 1 in 60,000. However, statistics from the National Climatic Data Center (NCDC) (National Climatic, 2005) shows that

between the years 1950 and 2005, there have only been 329 tornadoes in California. This ranks California 32nd in the nation for tornado frequency according to the Golden Gate Weather Service (Golden Gate Weather, 2004).

The NCDC also reported that none of tornadoes reported in California were greater than an F3 on the Fujita scale, which rates the strength of the tornado on a scale of F0 through F5, with F5 being the strongest. Furthermore, although there were a total of 85 tornado related injuries in California during the study period, there were no recorded fatalities. As such, it is reasonable to conclude that a person in Southern California is more likely to die from other hazards, such as a flood, wildland fire or an earthquake, than they are from a tornado, even though this contradicts the National Safety Council's statistics based on nation-wide averages.

The one remaining hazard that was not specifically included in the National Safety Council report was terrorist attack. This is likely because the frequency of terrorist attacks in the United States has been historically low, and somewhat anomalous. Although the topic has received a great deal of media attention since 9-11, there is little information available that places it in perspective with other hazards. Rothschild (2001) attempted to put the risks of dying in a terrorist attack in perspective through the following observations:

. . . let us assume that each week one commercial aircraft were hijacked and crashed. What are the odds that a person who goes on one trip per month would be in that plane? There are currently about 18,000 commercial flights a day, and if that person's trip has four flights associated with it, the odds against that person's

being on a crashed plane are about 135,000 to 1. If there were only one hijacked plane per month, the odds would be about 540,000 to 1. (p. B07)

Rothschild goes on to make additional illustrations of the impact of other terrorist scenarios, each providing strong evidence that the odds of the average American dying in such an attack are likely to be lower than the other hazards used in the questionnaire.

Table 2

Adjusted Statistical Odds of Dying for the Average American.

Hazard	National Safety Council mortality ranking	Mortality ranking adjusted for local factors ^a
Car Crash	1	1
Fire in the home	2	2
Airplane Crash	3	3
Hurricane	4	9
Tornado	5	7
Wildland Fire	6	4
Earthquake	7	5
Flood	8	6
Terrorist attack	9	8

^aAdjustments made for specific geographic , geologic, and environmental factors for the San Bernardino City CA.

Using the NSC data, and with the caveats noted above, Table 2 places each hazard in numerical order based on the odds of dying from each one. In addition to the statistical placements in the second column, which are based in the NSC data, the third column of

Table 2 also shows an adjusted ranking based on the authors analysis of the studied literature.

As Tables 1 and 2 both show, the top three risks that pose the greatest mortal hazard to the residents for the San Bernardino CA. area are, in order of risk, car crashes, fire in the home, and airline crashes. Because the study's methodology focuses on the top three risks in the questionnaire, the exact ranking of the remaining hazards is not highly significant. However, because of the rarity of some of the remaining events, the selection of them as being a significant threat by the questionnaire respondents offers insight into how far off some respondents may be in their estimation of personal risks. This impact of this divergence will be further evaluated by looking at these respondents' choices to maintain a working smoke alarm in their home. Details on this aspect will be covered in the Procedures and Findings sections of this document.

Procedures

Descriptive research methods were used to assess the relationship between a community member's understanding of their level of personal risk from specific hazards, the presence or absence of a working smoke alarm in their residence, and any impact that these trends had on age groups older than 65 or younger than 14. Several steps were taken to assess the strength of these relationships, and its significance in defining strategies for decreasing life loss due to residential structure fires by increasing smoke alarm use in the community.

The research process began with a literature review of related subject matter. The literature review consisted of a selection of textbooks, journal articles, periodicals, databases, and Internet articles. These sources came from the National Fire Academy's

Learning Resource Center (LRC), the Armacost Library at the University of Redlands CA., databases from local educational institutions, and the City of San Bernardino, and various Internet sites.

A questionnaire was then developed to collect information on the presence of working smoke alarms in residential occupancies, the number of occupants over age 65 and under age 14 in each occupancy, and the ability of the responding occupant to correctly identify the level of risk associated with a given list of nine hazards (see Appendix A). The author and SBFD's Fire Marshal, Doug Dupree, developed the questionnaire. Before the questionnaire was administered, it was reviewed by Fire Prevention Officers (FPOs) from the department's fire prevention bureau for input and evaluation.

The questionnaire was given to 474 San Bernardino City residents over the course of 4 months. It was administered by FPOs from the fire department's fire prevention bureau during the process of performing annual fire prevention inspections. The author met with each of the FPOs prior to issuing the questionnaires to explain the process and expectations of getting them completed. They were asked to get as many questionnaires completed and returned as they could in the 4-month period. The 474 that they were able to return was a large enough number to provide useable data for this research project.

Once each questionnaire was filled out, it was returned to the author. From there, each questionnaire was evaluated for completeness. Any questionnaires with incomplete or unclear information were eliminated from the study. Data from the remaining completed questionnaires were entered into a Microsoft Access database that was

specifically built to capture data for this study. Queries from this database were used to help form the conclusions of the study.

The questionnaires consisted of seven questions, which were printed on 4 inch by 11-inch cardstock. When a questionnaire was administered, the FPO would begin by filling out the first six questions. The first two questions involved physically checking for the presence of at least one properly functioning smoke alarm in the residence. If a smoke alarm was present but not functioning, the inspector would indicate why, using a forced choice format that included improper location, dead or missing batteries, lack of maintenance, or having the hardwire power supply disconnected (See definitions at the end of the section for clarification on these terms).

Questions three and four were asked verbally by the FPO to ascertain how many people living at the residence were either over the age of 65, or under the age of 14. This data would be used to determine if there is a connection between risk perceptions, smoke alarm use, and citizens in these age classes. Question five and six were also asked verbally by the FPO, which inquired if anyone living in the residence was a smoker, and the gender of the respondent. Although responses from these questions were captured in the database, ultimately, they were not used for this research project.

The last question provided respondents with a list of nine specific hazards, which included earthquake, residential structure fire, wildland fire, flood, terrorist attack, tornado, hurricane, automobile crash, and airplane crash. These hazards were selected for this study because of the likelihood that an average person could recognize and relate to each one, although each one occurs with varying degrees of frequency. Each of these risks were evaluated in the literature review to determine the statistical level of risk that

each hazard has for the average American, and the average person living in the San Bernardino CA. region.

For this question, respondents were physically given the questionnaire by the administering FPO so that they could read and review the list of nine specific hazards. Respondents were then given instructions both verbally from the FPO and in writing on the questionnaire to select the hazards listed that they think represents the top three risks to them. The respondents were instructed to write the number 1, 2 or 3 next to their selected hazards, with the number 1 posing the greatest risk, number 2 the second highest risk, etc. The FPO would be available to guide the respondent through the procedures, but they were instructed not to give clues or opinions on the levels of risk associated with the hazard. The function of this final question was to help determine how accurately respondents could identify the level of risk that each hazard presents to them, and how they rated having a fire in their home in comparison to other types of hazards.

Once the questionnaires were collected and entered into the database, the responses regarding perceived level of risk were evaluated with two different approaches. The findings from each approach were then matched with the presence or absence of a working smoke alarm to determine if there was a relationship between a person's perceptions of risk, and the presence or absence of a working smoke alarm in their home.

In the first approach, the data was evaluated to determine how closely each respondent's overall perception of the risk from the hazards in the questionnaire matched up to the statistically determined risk from each hazard. This statistical risk was based on the findings in the literature review, and modified to include the region specific factors of the San Bernardino CA. area.

Based on their ability to correctly identify the top three risks in correct order, respondents were placed into one of the four categories shown in Table 3. These categories were defined and selected as a comparative tool, and were not validated through any other mechanism to determine if other variables may have influenced a respondents perception of risk. Even so, they provided a reasonably accurate measure of risk perception for the purposes of this research.

Table 3

Classification of Respondents Based on Their Ability to Correctly Select the Risks That Statistically Pose the Greatest Threat to Them.

Respondents assessment of risk	Classification
Correctly identifies the top three risks in correct order	Highly accurate
Correctly identifies top three risks, but not in order	Accurate
Correctly identifies two out of three top three risks in any order	Marginally accurate
Correctly identifies only one or less of the top three risks in any order.	Least accurate

Once all the respondents were placed in a category, further analysis was done to determine how many in each category did or did not have a working smoke alarm in their home. This comparison provided a benchmark for determining the strength of the relationship between respondents' levels of risk understanding, and the presence or absence of working smoke alarms in their home.

The second approach to the data was performed by determining how many of the respondents that had a working smoke alarm in their home also selected fire in the home as any one of the top three hazards that they believe pose the greatest risk to them. This

was then compared to the respondents that did *not* have a working smoke alarm in their home, but did select “fire in the home” as any one of the top three hazards that pose the greatest risk to them. For this part of the analysis, the order of the risks selected, or risks other than “fire in the home” were not taken into consideration.

The final analyses of the questionnaire data focused on community members over the age of 65 or under the age of 14. The objective was to determine if there were trends in risk perception/smoke alarm use that were unique to homes with occupants in these age groups in comparison to the general trends found in this research. The research then evaluated what impact, if any, these trends may have on the occupants in these age groups. Homes with occupants in these age categories were extracted from the main data set, and separated into two groups, those with occupants under age 14, and those with occupants over age 65. The same general methodology that was used to analyze the overall trends was also used to determine any impacts on the specified age groups.

Assumptions and Limitations

Although all of the respondents to the questionnaire were the full-time occupants of the residences inspected, each residence was a multi-family dwelling consisting of four units or more. Because SBFD’s fire prevention bureau does not inspect residential occupancies with less than four individual units, there was no existing mechanism to administer the questionnaire to community members living in these occupancies in the identical fashion that was used for multi-family dwellings. This factor may skew the outcome of the study to some degree, as there is evidence that smoke alarms are more likely to be present and functioning in multi-family occupancies than in single-family occupancies (United States Fire, 2004). This is believed to be because most smoke alarms

in multi-family occupancies are provided and maintained by property owners or managers.

In addition, because the SBFD has been aggressively enforcing smoke alarm ordinances for multi-family dwellings for several years, most owners and managers of these properties are familiar with the inspection and enforcement process. Therefore, it is reasonable to conclude that the majority of them understand that they must keep their buildings equipped with working smoke alarms in order to avoid penalties. This level of enforcement has not been used in occupancies with less than four units in the City of San Bernardino.

Even with the intervention of property owners and managers however, there is still a level of responsibility that the occupant must take to ensure that smoke alarms in their residence remain functional. Certainly, there are many opportunities to neglect battery replacement, or to purposely render the smoke alarm inoperable. Each of these has been identified as the most common reason that smoke alarms do not function in a fire (United States Fire, 2001). Furthermore, a recommendation from the National Fire Protection Administration calls for occupants to test their smoke alarms on a monthly basis in order to ensure operability (Ahrens, 2004). This is certainly beyond what would be reasonably expected from a property owner or manager.

With this in mind, it is reasonable to conclude that it is within each occupant's power and responsibility to maintain a working smoke alarm in their home. In fact, the level of control that the occupant has on the presence or absence of a working smoke alarm, although perhaps not as high as a single-family property owner, is significant

enough that their actions regarding smoke alarm use and maintenance provides useable information for this study.

Another limitation in the methodology may be a degree of bias that is brought about by having the questionnaire delivered and overseen by FPOs. Because the FPOs represent the fire department, and because they were in the process of an official fire inspection when the questionnaire was administered, respondents may have felt compelled to give what they believe was the right answer when asked about their perception of the risk of fire in particular. This bias may have resulted in a greater number of respondents placing fire related hazards in a higher risk category than they may have normally given.

Because there are other hazards in the questionnaire that also occur with relative frequency, a respondents bias toward fire related hazards could ultimately lower them from a classification of highly accurate to a classification of somewhat accurate or below. Because the respondent is selecting three of the hazards, the impact of the potential bias toward fire hazards is mitigated to some degree.

Definitions

FPO: Fire Prevention Officer. Job classification in the SBFD. Employees in this classification are responsible for conducting fire prevention inspections in occupancies throughout the city that are regulated through the city's municipal code.

Hardwired smoke alarm: A smoke alarm that is directly wired and powered primarily through a structure's 110-volt domestic house current. Hardwired smoke alarm

devices may also operate off of an internal conventional battery backup system in case the house current fails.

Hazard: A possible source of danger.

Improper location: The permanent or semi-permanent placement of a smoke alarm in any location in the residence where it would not be adequately exposed to the products of combustion generated from a fire in the home, or cannot generate enough decibels to alert occupants. Either of these conditions could result in the failure of the device to give adequate warning to the occupants. Examples of improper location would be in a dresser drawer, under a bed, or any other location low enough or secluded enough to be inadequately exposed to a smoky environment.

Lack of maintenance: A term used in this research to describe a smoke alarm that, for whatever reason, fails to function because of housekeeping issues. This could include large accumulations of dust, dirt, paint, insect infestation, rodent damage, or any other element that would render the smoke alarm inoperable, but would also be readily evident to the occupant should they perform a regular smoke alarm check.

Risk: The potential harm that may arise from exposure to a hazard or hazardous environment.

Smoke Alarm: A device that makes noise upon detection of smoke in the immediate area. Some devices may be interconnected so that if smoke is detected in one area of the building, all alarms in the same building will sound.

Smoke Detector: A device that detects smoke, and then sends a signal to a remote location where the signal is monitored and fire response officials are notified. A smoke detector does not make noise where it is physically located.

Results

Through an extensive review of the data gathered, and with the supporting information found in the literature review, answers to the specific research questions were established. In order to establish a framework for interpreting the data gathered, the first area to be examined was the number of respondents who had working smoke alarms and how many did not.

A total of 474 questionnaires were filled out by community members and returned to SBFD's fire prevention bureau. Of these, a total of 12 questionnaires were eliminated due to incomplete or unclear information. This resulted in 462 questionnaires that were used for this research, each representing a single household.

Of these 462 households represented, 345 of them (75%) had at least one working smoke alarm in their residence. Of the remaining 117 households, 33 of them (7%) had no smoke alarm, and 84 of them (18%) had one or more a smoke alarm(s) in the residence, but none of them were functional. Collectively, this showed that 25% of the participating households did not have the protection of at least one properly functioning smoke alarm.

Of the 84 households that did have a smoke alarm present, but not functioning properly when tested by a FPO, 38% failed to function because of dead or missing batteries. As Table 4 shows, this was the most common reason that a smoke alarm failed

to function. Having the hardwired power source disconnected was the second leading cause of non-operating smoke alarms, comprising 21% for the total failures, followed by lack of maintenance at 19% of the total failures. Improper location was the least common reason for smoke alarm failure, representing 8% of the total failures. The remaining 11% of the questionnaires indicated that the smoke alarm was present and not functioning, but did not give the specific reason why.

Table 4

Reasons Why Smoke Alarms in Study Failed to Function when Tested.

Reason for smoke alarm failure	Total	% of total
Dead or missing batteries.	32	38%
Hardwire disconnected.	18	21%
Lack of maintenance.	16	19%
Improper location.	7	8%
Reason not reported.	11	13%

Perception of Personal Risk

Based on the responses to the questionnaires, the hazard that was most frequently selected as posing the greatest risk to the respondent was earthquakes, which accounted for 37% of the total responses. This was followed by house fires (27%) and car crashes (14%). In comparison to the statistical odds that the hazards used in this research would be of substantial risk to the questionnaire respondents (see Table 2), these findings suggest that overall, there was a moderate degree of divergence between perceived and real risks.

As Table 5 shows, there was some degree of disparity between actual statistical risk, and what respondents perceived as their number one risk. This disparity was evident in six out of the nine categories.

Table 5

Statistically Based Ranking of Risk in Comparison to Questionnaire Respondent's Ranking of Perceived Risk.

Hazard	Ranking of statistical risk ^a	Rank based on questionnaire respondent data.	Percent of questionnaire respondents
Car Crash	1	3	14%
Fire in the home	2	2	27%
Airplane Crash	3	6	4%
Wildland Fire	4	4	7%
Earthquake	5	1	37%
Flood	6	7	3%
Tornado	7	8	1.9%
Terrorist attack	8	5	5%
Hurricane	9	9	1.5%

^a Based on the National Safety Council's (NSC) statistical risk, and adjusted for region specific risk factors of the San Bernardino CA area (see procedures section for explanation of adjustment factors)

The greatest divergence occurred with the perception of earthquake risk. Earthquakes were ranked above four other risks that statistically pose a greater threat according to National Safety Council statistics that were modified to reflect risk factors

inherent to residents of the San Bernardino CA. area. The majority of the questionnaire respondents were able to correctly assess their risk related to fire in the home, wildland fire, and hurricanes.

As explained in the procedures section of this research, questionnaire respondents were placed in one of four categories based on their accuracy in assessing their personal risk associated with the hazards given (see Table 3). The categories were labeled highly accurate, accurate, marginally accurate and least accurate. This was done to provide a framework for additional analysis of risk perception and smoke alarm use.

As Table 6 shows, only 4.8% of the total respondents fell within the categories of highly accurate and accurate. The remaining 94.2% of the respondents fell into the categories of marginally accurate or least accurate.

Table 6

Categorizations of Respondents Based on their Ability to Correctly Identify Hazards that Pose the Greatest Risk to Them.

Category	Description	Percentage of respondents
Highly accurate	Correctly identified the top three risks in correct order	1.2%
Accurate	Correctly identifies top three risks, but not in order	3.6%
Marginally accurate	Correctly identifies two out of three top three risks in any order	39.6%
Least accurate	Correctly identifies only one or less of the top three risks in any order.	55.6%

Based on the methodology used in this view of the data, there is evidence that a substantial number of respondents have a perception of personal risk that is incongruent with actual risks that face them. Furthermore, the data suggests that the gap between real and perceived risk is significant. This appears to be true even when taking into account the assumptions and limitations of the research procedures.

Association Between Risk Perception and Smoke Alarm Use and Maintenance

Although the research data indicates that the majority of the respondents' overall perception of risk is generally not consistent with their actual risk, there were indications that respondents with more accurate perception of risk were more likely to have a working smoke alarm in their home. Conversely, respondents with less accurate perceptions of risk were less likely to have a working smoke alarm in their home.

As Table 7 shows, all of the respondents that were categorized as highly accurate or accurate in their overall risk perception had a working smoke alarm in their home. Of the remaining respondents that had a working smoke alarm in their home, 42% fell into the category of marginally accurate. This is in comparison to respondents that did not have a working smoke alarm, of which only 30% were classified as marginally accurate. The trend continues in the category of least accurate, where 51% of the respondents that had a working smoke alarm, compared to 70% that did not. This data suggests that there is a connection between a person's accuracy in their overall understanding of personal risk and the presence of a working smoke alarm in their home.

Additional analysis of the data provided further evidence suggesting that individuals who perceive fire in the home as a significant risk are more likely to have a working smoke alarm in their home. This trend could be seen by looking specifically at

the responses to the hazard of fire in the home. Although having a fire in the home did not represent the greatest statistical risk to the questionnaire respondents, 30% of those that had a working smoke alarm in their home listed it as what they believed was their most significant risk. In contrast, of those respondents that did not have a working smoke alarm, only 19% of them listed fire in the home as their most significant risk.

Table 7

Relationship Between Smoke Alarm Status and Accuracy of Risk Perception.

Status of smoke alarm in respondent's homes	Risk perception category of respondents			
	Highly accurate	Accurate	Marginally accurate	Least accurate
Present and working	2%	5%	42%	51%
Not present or not functioning.	0%	0%	30%	70%

The same trend was found by analyzing how many respondents listed fire in the home in any one of their top three selections for hazards that they believe pose the greatest risk to them. Of the respondents that had a working smoke alarm in their home, 81% listed fire in the home as what they perceive to be one of their top three greatest risks. Of the respondents that did not have a working smoke alarm, only 56% listed fire in the home as one of their top three risks (See Table 10).

Collectively, this data shows that there is a notable relationship between an individual's perception of personal risk and their choice to take preventative measures to address it. When viewed specifically in the context of having a fire in the home, those

who had a greater concern about this specific risk were more likely to maintain a working smoke alarm.

Impact on Community Members Over the Age of 65.

Of the 462 homes represented in this research, 30 (6%) had at least one or more occupants over the age of 65. This represents a total of 34 individuals over age 65 that are in the study group. Although this represents a relatively small portion of the total data set, it does appear to be in reasonable proportion to the city's population of residents that are over the age of age 65, which is 8.2% (United States Census, 2000).

Of the households that had at least one occupant over the age of 65, 25 of them (83%) had a working smoke alarm. This is 8% above the overall trend found in this research. Of the total individual occupants represented in the research over age 65, 82.4% lived in a home that had a working smoke alarm, and the remaining 17.6% did not.

For this age group, the relationship between overall accuracy in risk perception and the presence of a working smoke alarm went against the overall trend. Using the research's method for determining the overall accuracy of a respondent's risk perception, the data shows that respondents in homes with occupants over age 65 which did not have a smoke alarm had a *more* accurate perception of risk than those that did (see Table 8). However, as Table 10 shows, when analyzed strictly in the context of how many of the respondents chose fire in the home as one of their top three risks, the trend of this group comes closer in line with the overall trend. Of the 25 homes with occupants over the age of 65 that had a working smoke alarm, the occupants questioned in 17 of them (68%) listed fire in the home as one of their top three risks. In the remaining 8 homes that did

not have a working smoke alarm, none of the occupants listed fire in the home as one of their top three risks.

Table 8

Relationship Between Smoke Alarm Status and Accuracy of Risk Perception in Occupancies with Adults Over the Age of 65.

Status of smoke alarm in respondent's homes	Risk perception category of respondents			
	Highly accurate	Accurate	Marginally accurate	Least accurate
Present and Functioning	0%	0%	36%	64%
Not present or not functioning.	0%	0%	40%	60%

The trend of accurate risk perception and the presence of working smoke alarms in this age group was not as strong in comparison to the general trend, or the trend found in homes with occupants under the age of 14. However, the data still suggests that there is a relationship between accurate risk perception and the presence of a working smoke alarm with community members over the age of 65.

Impact on Community Members Under the Age of 14

The research showed that 221 (48%) of the 462 households questioned had one or more occupants under the age of 14 years old. Collectively, these households represented 421 individual occupants under the age of 14 in the study group. This calculates to 0.9 occupants under age 14 per household, based on the total number of households in the data set. This ratio of occupants under age 14 per household is identical to the ratio for

the entire City of San Bernardino CA. according to data from the U.S. Census Bureau (2000).

Of the 221 households in the research that had at least one occupant under the age of 14, 160 of them (73%) had a working smoke alarm, and the remaining 61 (27%) did not. As Table 9 shows, the relationship between accurate risk perception and the presence of a working smoke alarm in this group was nearly identical to the overall trend. However, there is an indication that some elements of this trend may have a slightly greater negative impact on those occupants under the age of 14.

Table 9

Relationship Between Smoke Alarm Status and Accuracy of Risk Perception in Occupancies with Children Under the Age of 14.

Status of smoke alarm in respondent's homes	Risk perception category of respondents			
	Highly accurate	Accurate	Marginally accurate	Least accurate
Present and Functioning	1%	4%	43%	52%
Not present or not functioning.	0%	0%	26%	74%

Of the households that had one or more occupants under the age of 14, the average number of individuals per household under the age of 14 living in homes that had a working smoke alarm was 1.8. In comparison, the average number of individual occupants per household under the age of 14 living in homes that did not have a working smoke alarm is 2.4. Although this is not a substantial difference, it does indicate that while more of the occupancies that house children under age 14 had working smoke

alarms, those that did not may have a higher potential for exposing more children to a single fire event.

Table 10

Status of Smoke Alarms in Relation to Respondents' Selection of "Fire in the Home" as one of their Top Three Perceived Risks.

Status of smoke alarm in respondent's homes	"Fire in the home" as one of the top three responses		
	All respondents	Homes with occupants > 65 yrs.	Homes with occupants < 14 yrs.
Present and Functioning	81%	68%	84%
Not present or not functioning	56%	0%	13%

In summary, the data indicated that there was a low level of accuracy in the majority of the respondent's ability to recognize which hazards pose the greatest risk to them. However, the data also indicated that people with a more accurate perception of risk, and those who see a fire in their home as a significant threat, are more likely to have a working smoke alarm. Collectively, this offers the SBFD a foundation to build upon to improve smoke detector use by the citizens in the City of San Bernardino.

Discussion

Analysis of the data collected offered insight into several trends that may help the SBFD better define some of the deeper causal factors contributing to the civilian fire fatality problem in the City of San Bernardino. As such, the research has provided a starting point for new education and enforcement programs and techniques.

With 93% of the occupancies used in this research having a smoke alarm installed (working or not), the City of San Bernardino is on par with national estimates for the number of households that have a smoke alarm installed (Consumer Product, 2004). Furthermore, it was encouraging to see that only 18% of the occupancies had smoke alarms that were not functioning properly, considering that some national estimates put the number of non-operating smoke alarms as high as 60% (Smith, 1995).

Although these are positive findings, they should be kept in context. As indicated in the limitations of this study, multi-family dwellings, such as those used in the research, statistically have a higher percentage of working smoke alarms than single-family homes (United States Fire, 2004). Even so, as stated earlier, the occupants have a great deal of control over installing, requesting installation, and maintaining or disabling a smoke alarm in their residence. Hopefully, this increased number of working smoke alarms is an indicator of a positive trend.

In analyzing the reasons why smoke alarms were present but not functioning, it is not surprising to find that missing or dead batteries were the leading cause. According to Ahrens (2004), this trend is typical across the United States. It is interesting to note, however, that even with SBFD's program that provides smoke alarm batteries to residents of San Bernardino City free of charge, this problem is still common among the city's residents.

This finding bolsters the argument that the problem of smoke alarms lacking in American residences will not likely be fixed with a technical solution, such as simply giving smoke alarms and batteries away. Instead, it will require a deeper approach that addresses and alters behavior patterns. This research offers evidence that educating

citizens on the actual risks that face them, and then how to mitigate that risk, would be a significant, effective component to such a program.

In reference to perception of personal risk, the research showed that most questionnaire respondents did not have a strong understanding of their true risks. Again, this does not appear to be unusual in comparison to broader statistics. The research results were similar to the National Fire Protection Association's study of risk perception, which found that more respondents believed that they were at greater risk from a tornado than they were from a fire in their home. This was in spite of the fact that statistical odds were dramatically to the contrary (Nicholson, 2004).

Research found in the literature review also indicates that a person's perception of risk develops in predictable ways, but that they do not necessarily center on facts. As Webber's et al (2002) research showed, a person's willingness to engage in risky behavior is typically generated from a lack of understanding of the potential negative impact of the risk, not a disregard for the potential negative outcome. These complexities of personal risk assessment were further illustrated by Finucane et al (2000) and Groner (1999) in their findings that people generally assess risk based on their own personal experiences, not necessarily factual information. This leads to patterns of thought regarding risk that becomes biased and distorted.

The significance of these findings for the SBFD is that they offer a direction for public education that puts emphasis on accurately portraying the risk of fire, not simply offering up a method to mitigate it. The need for such risk awareness based programs becomes more evident when considering Hall's (1999) findings that most people feel that they are safest in their home. Oglethorp and Monroe (1994) also offer support for risk

awareness programs in their research, which concluded that people must have a substantial amount of accurate information regarding the risks that face them if they are to make an informed choice to avoid them.

An important part of a developing risk awareness program like this for the City of San Bernardino would be putting the level of risk from each hazard into perspective when compared to the totality of potential risks. As Kunreuther, Meyer, and Van den Bulte found in their report for the National Institute of Standards and Technology (2004), simply providing the statistical odds for a single risk is not effective in helping people understand which risks should concern them. People must have some point of reference to help them determine if a risk is small or large. Based on these findings, and the results of this research, it is reasonable to conclude that some of the conventional risk reduction methods used by SBFD, such as providing free smoke alarms and batteries, may not be sufficient as they operate under the assumption that community members fully understand their risks in a factual perspective.

Further analysis of the questionnaire responses from this applied research project offers additional evidence that a greater emphasis on risk awareness in SBFD's fire risk reduction programs could lead to a decrease in life loss due to fire in the City of San Bernardino. This is first seen by assessing the relationship between the respondents ability to correctly identify personal risk and the presence of a working smoke alarm in their home. Although the majority of the respondents showed an inaccurate perception of personal risk overall, the respondents that had a working smoke alarm in their home consistently showed a better understanding than those that did not.

These findings regarding the impact of overall risk perception were supported by the second approach to analyzing respondents answers to the risk rating questions. This view of the data showed that 81% of the respondents that had smoke alarms in their home also listed fire in the home as one of the top three personal risks to them. This was in comparison to respondents who did not choose fire in the home as one of their top three risks, of which only 56% had a working smoke alarm in their home.

These numbers offer additional evidence that emphasizing risk awareness in fire related community risk reduction programs in the City of San Bernardino would be very effective in increasing smoke alarm use. According to Ahrens' estimates (2004), doing so could lead to a reduction in life loss due to fire of over 30%.

The research made several notable findings in studying the data on community members over age 65. The most positive finding was that the number of households with working smoke alarms in this group was 8% higher than the overall number of homes in the research that had a working smoke alarm. This is encouraging, as elderly adults have a significantly higher fire death rate than the average population (United States Fire, 2004).

The significance of not having a working smoke alarm in this age group is illustrated in the fact that the most common activity of an elderly adult prior to being fatally injured in a fire is sleeping (United States Fire, 2005c). Even with the research from the Consumer Product Safety Commission (2004) which questions the effectiveness of smoke alarms in waking older adults and children, the evidence is still overwhelming that the presence of a working smoke alarm in the home will significantly increase the

likelihood of surviving a residential structure fire. This is particularly true when occupants are sleeping at the time of the fire.

The research also showed that there is a connection between personal risk perception and the presence of working smoke alarms in households with adults over age 65. However, the connection was not as clear, and slightly weaker than the general trend. The first of two data analyses on the impact of personal risk recognition on smoke alarm use among occupants in this age group showed a surprising difference from the overall trend. In this analysis, the adults over age 65 who showed a more accurate recognition of risk were *less* likely to have a working smoke alarm in their home. In addition to being contrary to the overall trends found in this research, this finding is also in contrast to the research conducted by Hall (1999) and Webber et al (2002), who documented compelling evidence that people generally avoid risks that they understand can cause harm to them.

This first analysis was balanced, however, by the second analysis of the personal risk rating data in households with occupants over age 65. This analysis showed a clear connection between respondents that had a working smoke alarm present in their home, and their selection of fire in the home as one of their top three risks. The strength of this connection could be seen by the fact that in the same age category, the respondents who failed to select “fire in the home” as one of their top three risks also did not have a working smoke alarm. These findings were similar to the general trend found in this research project.

Even with this balance of evidence, the overall fire risk picture of community members over age 65 portrayed through this research shows that although this group may have a reasonable comprehension risk, they may not be as efficient in dealing with it as

they could be. This is understandable when one considers that most modern risk reduction practices involve newer forms of technology that are still not widely accepted by some in the older age groups. What younger generations consider simple practices, such as installing or checking a smoke alarm, or calling 911 on a telephone instead of dialing “0”, can be new and somewhat confusing for some older adults. Additional research into the behavioral trends of older adults in regards to coping with fire risk would be beneficial, as it may offer additional insight for education and mitigation programs.

The analysis of the data relating to occupants under the age of 14 showed many similarities to the overall trends found in this research relating to risk awareness and smoke alarm use. Because this overall trend reveals a deficiency in risk awareness that lends to fewer households having a working smoke alarm, its impact on those community members under the age of 14 is significant.

Fires and burns continue to be one of the leading causes of fatalities in children under the age of 14 (United States Fire, 2005b). Approximately 30% of the City of San Bernardino’s population is under the age of 14 (United States Census, 2000). Of the community members under the age of 14 that were represented in this research, 38% of them lived in homes that were not protected by a working smoke alarm. Furthermore, nearly 22% of the fire fatalities that have occurred in the City of San Bernardino over the past eight years have been children under the age of 14. These facts offer significant and compelling evidence of the need for the SBFD to focus risk reduction efforts specifically on this age group.

Conventional approaches to fire risk education in these younger groups often begin by introducing classic characters such as Sparky the dog, Smokey the bear, and other fictitious fire safety characters. The SBFD frequently uses a life-size Sparky the dog costume to draw attention to public events throughout the city. Although these characters offer an approach that is engaging for the younger age groups, the conclusions from Finucane et al. (2000) suggest that the positive, possibly even comforting feelings that characters like these generate could have significant influence on a person's judgment of risk. It is possible then that an overuse of approaches that focus more on the characters than on the fire safety message itself could not only be ineffective initially, but may also help develop a component of a person's inaccurate mental image of fire risk.

This is not to say that approaches using characters such as these do not have an effective place in a fire risk reduction program. However, a broader look at their effectiveness suggests that they must be used in proper measure and context. A study of the actual impact of these programs from the perspective of how they influence personal risk perception would be worthy of further study.

Further evidence of the need to focus on this age group was found in the average number of children per household under age 14 that were living in homes that were not protected by smoke alarms. The households that had occupants under the age of 14 that also had a working smoke alarm averaged 1.8 occupants under age 14 per household. In comparison, those households with occupants under the age of 14 that did not have a working smoke alarm averaged 2.16 occupants under age 14 per household. This increase suggests that when a fire event occurs in a residential structure with occupants under the age of 14, and that structure is not protected by a working smoke alarm, there is an

increased likelihood of multiple fire fatalities for occupants in this age group. This finding underscores the need to focus risk reduction efforts on this age group.

Recommendations

The findings of this applied research project suggest that there is a significant positive relationship between a person's accurate perception of personal risk, and their choice to maintain an operating smoke alarm in their home. This relationship appears to be even stronger when related to a person's concern about having a fire in their home. Furthermore, there is evidence that an inaccurate understanding of risk is connected to a decreased likelihood of having a smoke alarm in the home. This connection appears to have a notable impact on community members under the age of 14 and over the age of 65. Both of these age groups have one of the highest fatality rates in the nation.

By understanding these relationships, and capitalizing on them, SBFD can improve the effectiveness of its public education programs in reducing fire fatalities in the City of San Bernardino. A community level smoke alarm program that uses a comprehensive approach emphasizing risk orientation, smoke alarm maintenance and installation training, and physical provision of the smoke alarm itself would likely result in more households in the community having properly operating smoke alarms. Based on the statistical evidence noted in this applied research project, an increase in smoke alarm use in the City of San Bernardino would decrease the current mortality rate due to fire, which is a positive outcome for the entire community. To that end, several recommendations should be considered, based on the findings of this research.

As the research showed, an individual's knowledge and understanding of personal risk that has developed through their own experiences is typically flawed. Therefore,

accurate understanding of one's actual risk factors and probabilities will come largely from education. As such, the SBFD should re-evaluate the learning objectives of their public education programs to ensure that they emphasize an accurate portrayal of the risks that affect the residents of San Bernardino City, as well as how to deal with them appropriately.

Curriculum for education programs such as this must address a broader range of risks than simply those related to fire safety. As this research shows, the City of San Bernardino is faced with many different types of hazards with varying levels of risk associated with each. Although the SBFD is transitioning away from the traditional view that its role is solely to address fire related issues, current events and public expectations dictate that their role must continue to diversify. Clearly, there are few entities for the community to turn to outside the fire department that are equipped to effectively address the preparation, mitigation and response issues related to the hazards that threaten the City of San Bernardino.

Another reason for maintaining a broad view of hazards in community risk reduction education is to help citizens keep potential risks in perspective. Evidence from the literature review and the questionnaires support the fact that people will react in some way to avoid or mitigate a hazard that they feel is a significant risk to them. The key then is to ensure that community members recognize their true risk factors. Once that is accomplished, the community members are prepared mentally to learn and put into practice effective mitigation techniques and positive behavioral changes. Based on the findings of the research, it is not reasonable to expect such behavioral changes to take place until the risks are realized in proper perspective.

The SBFD should also take steps to ensure that the public is aware of the fire mortality problem in San Bernardino City. This should be approached in two ways. First, the historical fire mortality statistics for the City of San Bernardino shown in this research are a compelling testament to the magnitude of the fire problem. Therefore, they should become a staple item in all fire safety awareness material presented to the public.

Second, when a fire fatality occurs, the fatality itself and the ways that it could have been prevented should become a highly publicized issue. Typically, local media will cover such an event within 24 hours, which will alert much of the public about the occurrence. However, following up on the fatal fire to keep the tragedy in the public eye for an extended period is a approach that Chilton et al. (2002) suggests will not only reinforce the significance of the risk, but will also influence community members' response to it.

In both cases, the presentation of this material should be tailored to be age appropriate for the audience. In order to have a strong impact, adult audiences should be given the information in detail, including any failures of the occupants to heed fire safety practices, ways that the tragedy might have been avoided, the age groups of the deceased, the presence or absence of fire alerting or suppression systems, and the occupants activities at the time of the fire.

Presentations to younger audiences should be sensitive to the unnecessary fears that an overly graphic depiction of fatal fire incidents could generate. However, fire in the home must be depicted as a tragedy, and one that can and does happen in the City of San Bernardino. Any approach that downplays or ignores this reality will not likely produce the fire safe behaviors desired.

Once community members' assessment of risk has come into focus, the next step would be to provide them with the tools and knowledge to deal with the risk. The City of San Bernardino's smoke alarm giveaway program is an important step in ensuring that smoke alarms are readily available to residents at all income levels. Although the city has not seen a decrease in fire fatalities since the program's inception, it is clearly an important component of a risk reduction system that focuses in reducing civilian fire fatalities. Therefore, the program should be continued.

Steps should also be taken to broaden public knowledge of the smoke alarm giveaway program. This could be accomplished through existing public education programs, or by developing innovative communications channels where the importance of such issues can be relayed throughout the community. Several avenues for this type of communication are currently in place through existing community organizations. Some examples would be local Parent Teacher Associations (PTA), churches, business and service groups.

Several forms of public media are also available as a resource for SBFD, such as local cable access channels, newspapers, radio stations and billboards. Some of these resources have been used in the past by the SBFD for public education purposes, but on an infrequent basis. Additionally, typical public safety announcements have focused primarily on technical risk reduction techniques, such as changing smoke alarm batteries, but not on emphasizing the risk of fire itself.

Approaches such as these that focus on the technical aspects of how to protect one's self from fire make the assumption that people already understand the level of risk that fire poses to them. As the research shows, this assumption is incorrect in most cases.

Therefore, the SBFD should maximize their use of public media sources to inform the public about their true fire risks, as well as how to effectively deal with them.

Although having a working smoke alarm in the home is going to be primarily under the control of the adult members of a household, children can be an influential communication pathway to get adults in their home to learn more about risk and fire safety. Although a graphic depiction of the risks facing children may be too intense for this age group, other age appropriate programs that will bring the message home are available.

One such program is the National Fire Protection Association's (NFPA) Risk Watch curriculum set (NFPA, 2005), which is available to the public. This program focuses on children in preschool through eighth grade, and offers separate modules covering a broad range of hazards including earthquakes, floods, and wildfires. The programs Learn not to Burn module focuses primarily on the hazards of fire in the home, how to avoid the hazards, the need for working smoke alarms, and the basics of how they should be maintained.

The curriculum teaches 22 key fire safety behaviors that are incorporated into regular school subjects. This curriculum offers a balanced approach of demonstrating risk at an age appropriate level, and introducing mitigation techniques that are understandable and achievable by the child. In addition to providing another conduit for fire safety and risk information to get back to the adults in the household, programs such as these develop risk awareness at a young age that could improve the level of risk recognition in generations to come.

The research also found areas where the SBFD could help improve fire safety conditions for adults over the age of 65. As was identified with the rest of the community, public education programs that place emphasis on the true risks of fire will likely increase the number of working smoke alarms in this age group, thereby reducing fire fatalities.

Many of the same mediums for communicating risk education to the general public mentioned earlier in this research would also be effective for this age group. In addition, however, efforts should be made to deliver the education programs through senior citizen centers and community organizations whose membership consists largely of older adults.

The research also found that the connection between correct personal risk recognition and having a working smoke alarm in the home was not as strong in the over 65 age group as it was in the overall trend. This evidence suggests the need for additional research that looks deeper into the behavior patterns of older adults when coping with personal risk. This applied research project found that although most of the older adults questioned did not have a high accuracy level in assessing their personal fire risk, many of those that did recognize the significance of their fire risk still did not necessarily take appropriate steps to mitigate it. Determining why such a trend would happen could be a helpful piece in engineering an effective risk reduction program for adults in the City of San Bernardino, and in other communities.

Other approaches for this age group, such as putting a dual focus on risk awareness and a detailed introduction to the tools available to mitigate their risks should also be considered. One such program developed by the NFPA, called Remembering When focuses specifically on the hazards that pose the greatest risk to older adults,

including fire risks (NFPA, 2005). The program, which is also part of NFPA's Risk Watch public education series, can be delivered through group or individual sessions, or as part of a smoke alarm installation program.

The common element to each of these approaches to community risk education and reduction is that they must emphasize the real risks that face the community members of San Bernardino City. Furthermore, they must go beyond the technical aspects of personal risk reduction engineering, and focus heavily on adapting to a lifestyle of safe practices that are appropriate for the individual's risk factors. There is substantial evidence indicating that if the SBFD can raise fire risk awareness in the community, and thereby increase the number of homes with working smoke alarms, the City of San Bernardino will realize a steadily decreasing fire death rate.

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APPENDIX A

COPY OF RESEARCH QUESTIONNAIRE

**San Bernardino City Fire Department
Smoke Alarm Questionnaire**

ADDRESS

Apt.# _____

1. Smoke Alarm Present? (Circle)

YES NO

2. Is it working? (Circle)

YES NO

- a. If not, why? (Check all that apply)

Batteries dead/missing	
Improper location	
Lack of maintenance.	
Hardwire Disconnected	

3. Number of occupants in household under age 14? _____

4. Number of occupants in household over age 65? _____

5. Does anyone living in the house smoke?

YES NO

6. Gender of questionnaire participant M F

*(Ask questionnaire participant)*Of the following, what do you think the **top three** greatest risks to you are?

(Have respondent place a number "1" next to the biggest risk, "2" for the next biggest risk, "3" for the third biggest risk)

Earthquake	
A fire in your home	
Wildland fire	
Flood	
Terrorist attack	
Tornado	
Hurricane	
Car crash	
Airplane crash	